David Dellenbaugh's
SPEED&Smarts™
The newsletter of how-to tips for racing sailors *May/June 2015*

Comparative Analysis **Issue 134**

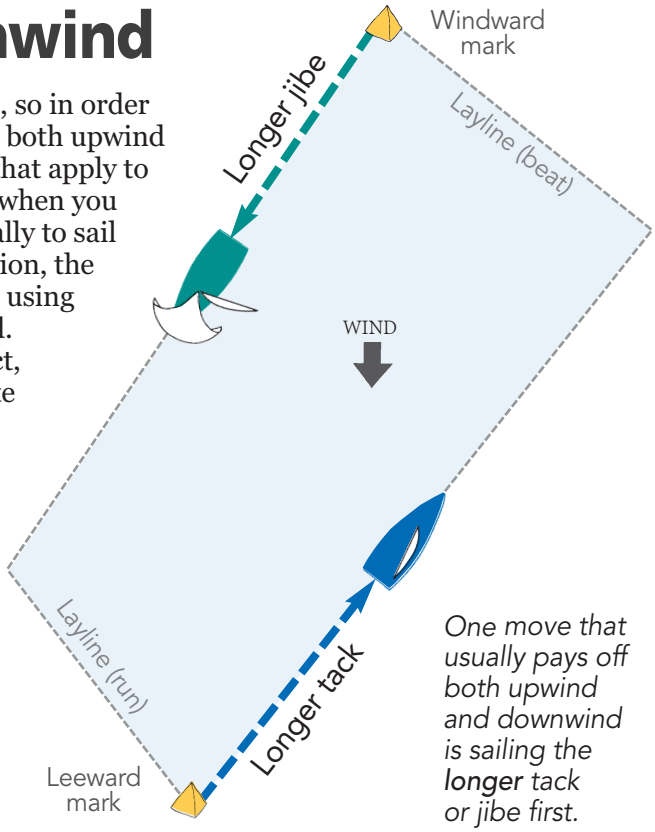
Upwind vs. Downwind

Most races today are sailed on windward-leeward courses, so in order to be successful sailors must be smart and fast at racing both upwind and downwind. Fortunately, a lot of the skills and strategies that apply to beats are also valuable on runs, and vice versa. For example, when you are not sure what the wind will do next, the best move is usually to sail the longer tack or jibe first (*see diagram*). Good communication, the ability to change gears, teamwork, identifying windshifts and using a strategic plan are all important both upwind and downwind.

At the same time, beats and runs are very different. In fact, many of the moves that work best upwind are exactly opposite to the ideal moves downwind. For example, on a windward leg you should usually sail *toward* the next windshift you are expecting. On a downwind leg, however, you want to sail *away from* the next shift (*see pages 10-11*).

There are many other differences. Changing tacks is less costly on runs, which means you can play smaller shifts and puffs downwind. You experience more windshifts on beats, so the shifts you see downwind are more likely to be persistent. Waves are your friends when sailing to leeward, but your enemies when going to windward.

It's very important to understand how beats and runs are different so you can apply the best strategies and tactics to each. That's what this issue is all about.



One move that usually pays off both upwind and downwind is sailing the ***longer*** *tack or jibe first.*

JH Peterson photo

It's not smart to get to the layline too early on any leg, but the risk of overstanding is less on beats because those laylines don't move as much (*see pages 14-15*).

US Sailing Team Sperry

More pressure will help you on any angle of sail, but it's especially important downwind because it usually has a huge impact on your angle and speed (*see pages 8-9*).

SPEED&Smarts

Comparative Analysis

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ISSUE #134

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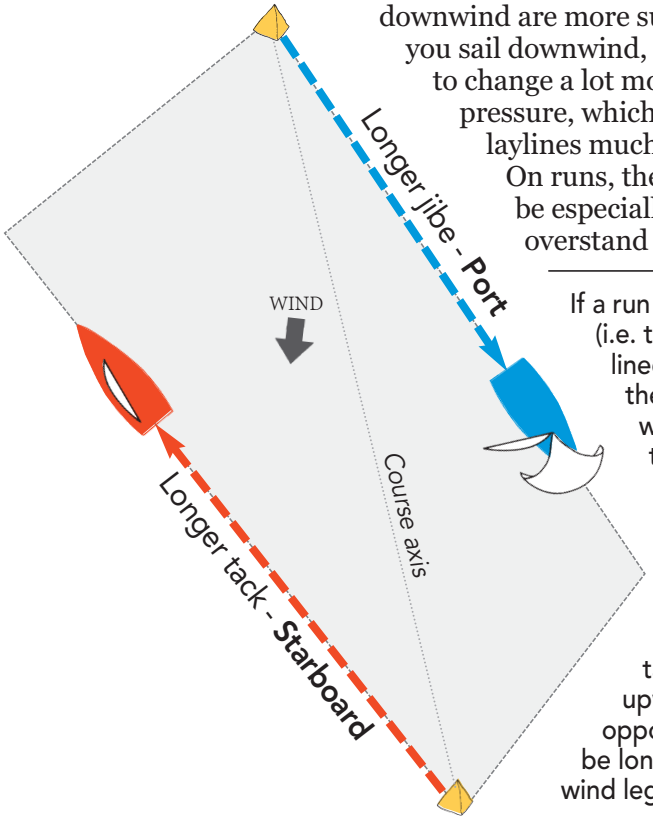
JH Peterson photo

Don't treat runs like beats (or vice versa)

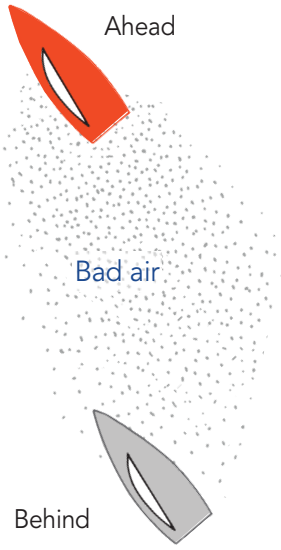
When you round the windward mark and bear off to a run, or round the leeward mark and start going upwind (*above*), you shouldn't automatically keep using the same strategic and tactical principles that worked on the previous leg. Racing upwind is inherently different than downwind, so each leg needs a unique new plan.

Some of the differences are obvious. For example, on beats the boats ahead have the advantage of using their wind shadows to slow or control the boats behind. On runs, however, this advantage goes to the boats that are behind (*see next page*).

Most differences between upwind and downwind are more subtle. The angles you sail downwind, for example, tend to change a lot more based on wind pressure, which makes picking laylines much more difficult. On runs, therefore, you must be especially careful not to overstand the leeward mark.



If a run or beat is 'skewed' (i.e. the course axis is not lined up with the wind), then one tack or jibe will be longer than the other. If a windward leg is skewed, you can expect the next leeward leg to be biased a similar amount. But if starboard tack is longer on the upwind leg, then the opposite jibe (port) will be longer on the downwind leg, and vice versa.

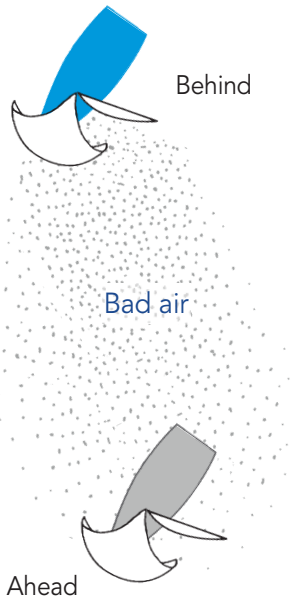


UPWIND: The boat ahead has the advantage.

On many upwind legs, the 'rich get richer.' The boats in the lead are to windward of the boats behind and this gives them several advantages: 1) The leaders can use their wind shadows to attack, slow or herd boats that are behind (to leeward of) them; 2) The leaders can more easily follow their strategic gameplan since (unlike the boats behind) they are able to sail in clear air much of the time; and 3) The leaders get puffs first and generally extend their lead whenever more pressure blows down through the fleet.

DOWNWIND: The boat behind has the advantage.

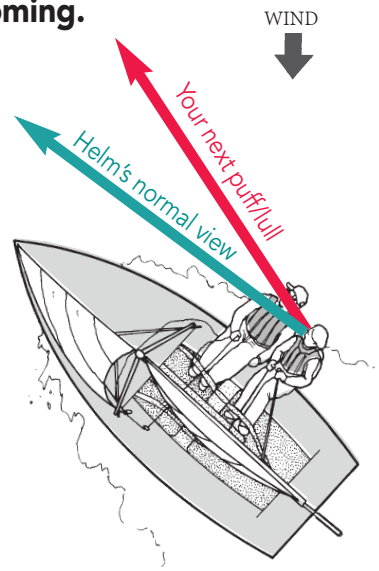
A run is much more of an equalizer because several factors favor the boats behind. Trailing boats are to windward of the boats ahead, so they can use their wind shadows to slow or herd the leaders. As the boats behind catch up and get closer to the leaders, their wind shadows become more effective (which does not happen when the leaders extend upwind). It's easier for the boats behind to find lanes of clear air and therefore pursue their strategy. Finally, the tail-enders get puffs first and are often able to close a lot of distance on the fleet by sailing faster and lower.



UPWIND: Easier to see what's coming.

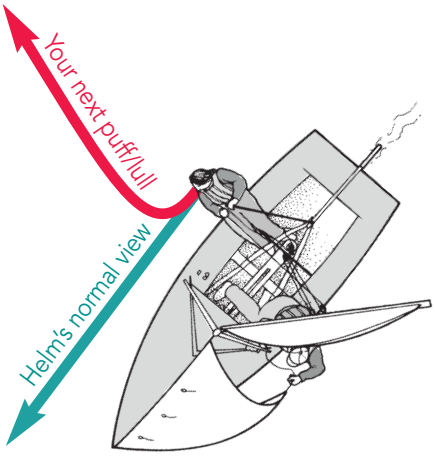
When sailing upwind, it's fairly easy for the helmsperson (or any other crew) to keep track of the wind that's coming. The wind that will hit the boat in the future can be seen in the direction of the apparent wind (red arrow). This is where all the boat's puffs, lulls and shifts are coming from.

On a beat, the helmsperson normally looks ahead toward the bow (green arrow) to watch the telltales, waves, instruments and the angle of heel. Since the apparent wind direction is fairly close to where he or she normally looks, it's relatively easy to see and keep track of upcoming changes in the wind at the same time.



DOWNWIND: Harder to watch for puffs and shifts.

When you're sailing downwind, however, the helmsperson still looks ahead (to see the spinnaker luff, instruments, waves), but the apparent wind is coming from behind his or her back. This makes it a lot harder to see puffs and lulls that are coming because it requires turning around and taking eyes off other important variables. Therefore, on runs it's important to make sure another crewmember is looking aft and talking about wind that's coming.



Getting a better view of the wind

It's important to see the breeze that's coming to you. This helps you change gears to keep the boat going fast, and allows you to play the shifts and puffs smartly. However, it's usually easier to see the wind when you're sailing downwind than when you're beating. That's because the higher you are off the water surface the farther you can see to windward. On a run, you can (and should) often stand up on the deck to get a great view of the wind quite far away. But on a beat you can't afford to do this because it takes too much weight off the rail and creates a lot of unwanted windage.

Waves: Friend or foe?

On most racing days, the waves move in roughly the same direction as the wind, so they push boats to leeward. This is great when you're going downwind, but not good when you're trying to sail upwind. As a rule of thumb, therefore, you try to avoid waves on beats, and head for the biggest waves on runs. Of course, there are always exceptions to a general guideline like this, and these are described below.

UPWIND: Look for flatter water.

Pounding into waves is not a fast way to go upwind, so look for ways to avoid bumpy seas. You can often find smoother water closer to shore or to leeward of points of land. However, be careful. Flat water is fast, but only if other conditions are equal.

If the waves are not the same across your course area, try to figure out why. Smaller waves are often the result of lighter wind or of more current flowing with the wind (or less current flowing against it). Neither situation is good for racing upwind.

The basic question you have to ask yourself is whether the benefits of sailing in flatter water outweigh the costs of sailing in lighter breeze or more adverse current. In most cases, the answer is no; that is, it would be better to sail in bigger waves where there is more wind and/or better current. Go for flat water only when you can avoid waves without sailing in lighter air or worse current.

DOWNWIND: Sail toward bigger waves.

On runs, bigger waves are usually good because they help you surf and move faster in a direction downwind. So when wave size varies across the course area, a good rule of thumb downwind is to head for areas where the waves are bigger.

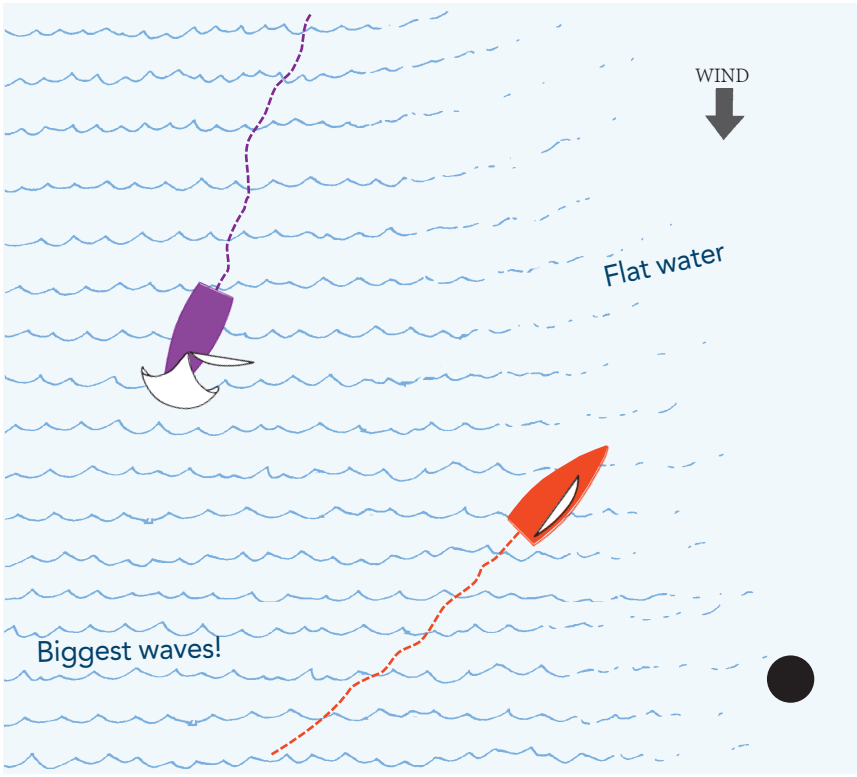
This guideline usually works well for two reasons. First, waves are good for surfing. Second, bigger waves often mean you are sailing in more breeze, which almost always makes you go faster on runs.

However, there are a couple of exceptions. Big waves might also indicate more current flowing against the wind (or less current flowing with the wind). This would not be good for racing downwind. So if current is the main reason for the existence of larger waves, think twice before you head there.

Another time when big waves may not be helpful is when you're going downwind faster than the waves. This is often the case when you are planing, but not fast enough to pop over every wave. If you find yourself struggling to get over the tops of waves, they are likely holding you back and it may be faster to sail where it's smoother. Flatter water is also less likely to produce broaching or pitchpoling, which is very slow.

JH Peterson photo

When you're sailing upwind, especially in waves, there is typically a lot more noise than when going downwind, so your communication has to be much clearer and louder.



Wind: Nature of shifts and puffs

Whether you are sailing upwind or downwind, the wind is constantly changing in direction and velocity. However, you will experience these shifts and puffs differently on beats than on runs.

When you sail to windward you are moving toward (into) the wind direction. In other words, the movement of your boat is opposite to the direction in which the puffs are moving. This means you will get the shifts and puffs at a faster rate than if you were, for example, sitting in an anchored boat.

Conversely, when you're going downwind you are sailing away from the wind. The movement of your boat is in the same direction as the wind, so you get the shifts and puffs at a slower rate.

Suppose you are sailing around on the starting line and you find that the wind is oscillating every five minutes. As you sail up the first beat, will the shifts come to you at the same rate?

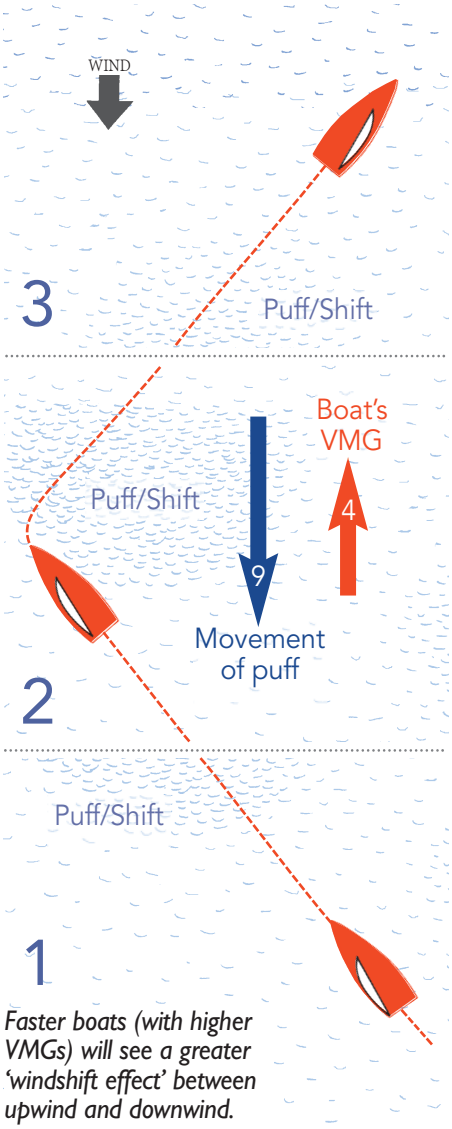
Since you are sailing upwind toward the shifts, you will get them faster, perhaps every 3 or 4 minutes. How about when you round the windward mark and sail down the run? Since you are sailing away from the shifts, you will get them less often, perhaps every 7 or 8 minutes!

Race-course implications

Converging with puffs and shifts at different rates on runs versus beats affects your strategy in two ways:

☛ You will experience fewer shifts on runs than on beats (and these shifts will last longer). This means it is more likely you should treat shifts downwind as persistent (because you may not see any more shifts on that leg).

☛ You can stay in each puff longer when you're sailing downwind than upwind (because on runs you are going in the same direction as the puffs). This means that it's even more valuable to find (and stay in) more pressure when you are sailing downwind.



Faster boats (with higher VMGs) will see a greater 'windshift effect' between upwind and downwind.

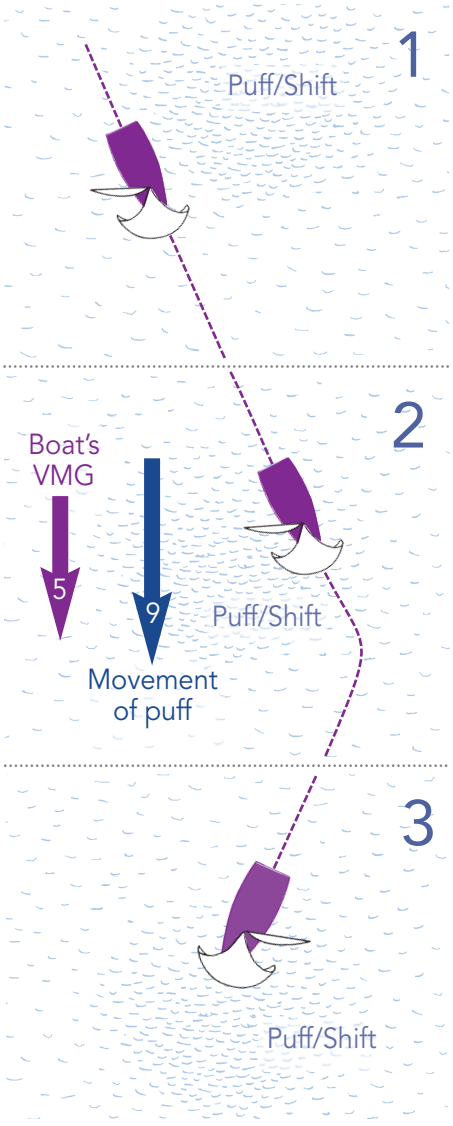
UPWIND: Lots of shifts.

On a beat, you are sailing toward (or into) the wind, so the speed at which you converge with shifts and puffs is roughly equal to the sum of the wind speed plus your velocity-made-good (VMG) to windward. In this case (left), that's 9 knots (windspeed) plus 4 knots (VMG), or 13 knots.

When sailing upwind, you converge more quickly with puffs and shifts because the puffs are coming toward you and you are also sailing toward the puffs. It's a bit like driving on a highway – the speed at which two cars converge is equal to the sum of their velocities toward each other. The speed at which you converge with puffs in a sailboat is roughly equal to the wind you feel while sailing (your apparent wind).

DOWNWIND: Fewer shifts.

On a run, you are sailing in the same direction as the puffs, so the speed at which you converge with them is equal to the wind speed **minus** your VMG to leeward. In the situation shown here (right), the wind speed is 9 knots and your downwind VMG is 5 knots, so the puffs and shifts are going by you at only about 4 knots. This is consistent with the very light apparent wind you often feel when you are running downwind.



Will the favored side of the beat also be better on the run?

If the boats on the right side of the first windward leg got to the windward mark first, does this mean you should play the same side of the ensuing run? The answer could be yes or no – it depends on a number of factors like windshifts, pressure and current.

Strategic conditions are always changing, so you can't assume that just because a certain side of the course was favored on one leg it will also be favored on the next. Even if the downwind leg takes place right after the boats went upwind, a lot can change in a short amount of time.

On the other hand, you can often discern trends on a windward leg that will help you predict what may happen downwind. For example, if the right side of the beat was better because of more wind velocity, that would favor the same side on the run. When gains are made due to pressure, the same side of the course will be favored both upwind and downwind.

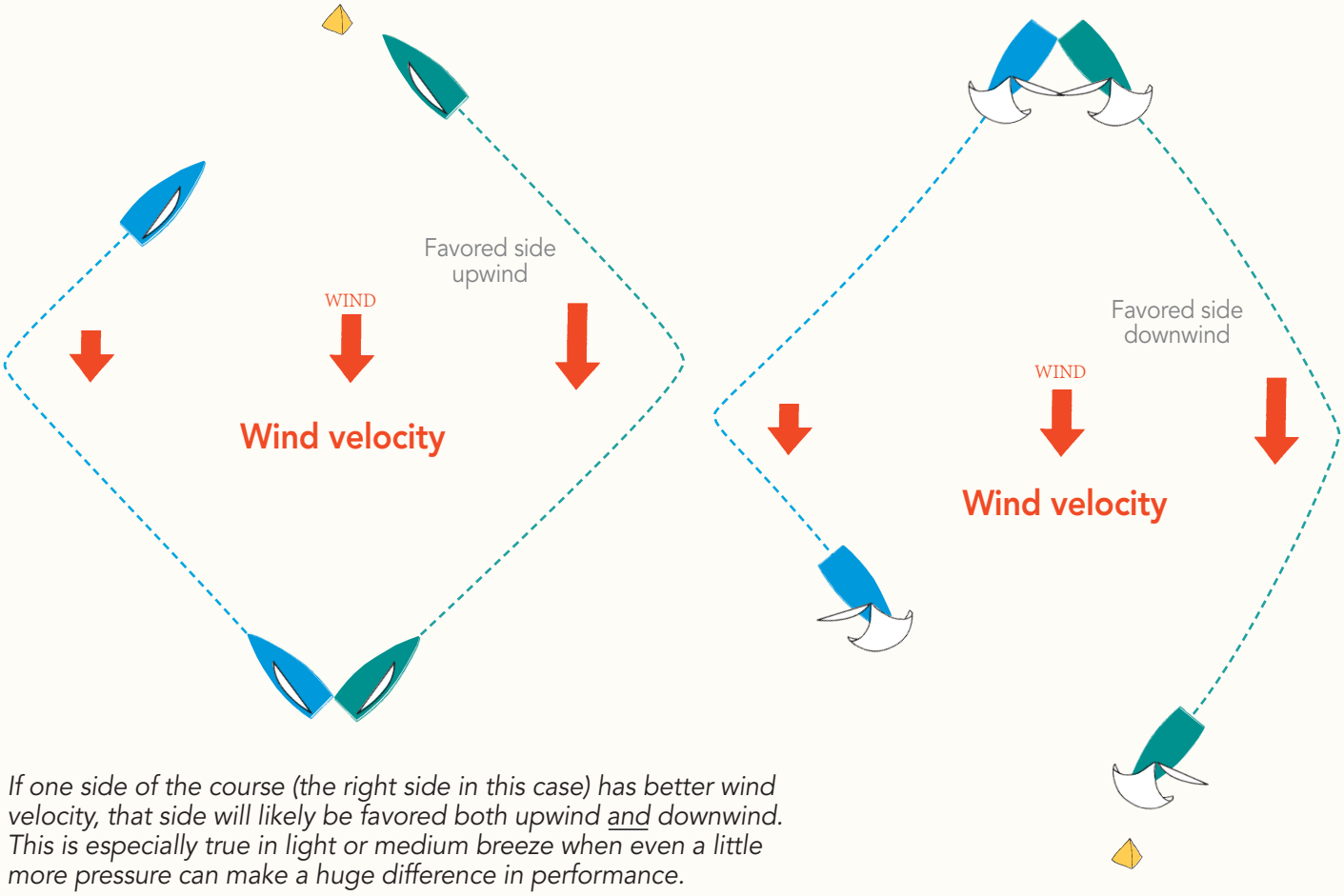
However, some conditions that favor one side of a beat actually favor the opposite side of the run. The presence of current is a good example. If the left side has better current for racing upwind, that means the right side will have better current for downwind.

So don't just round the windward mark and sail blindly toward the side of the run that was favored upwind. First figure out why the favored side was better upwind, and then consider whether this makes the same side better downwind or not.

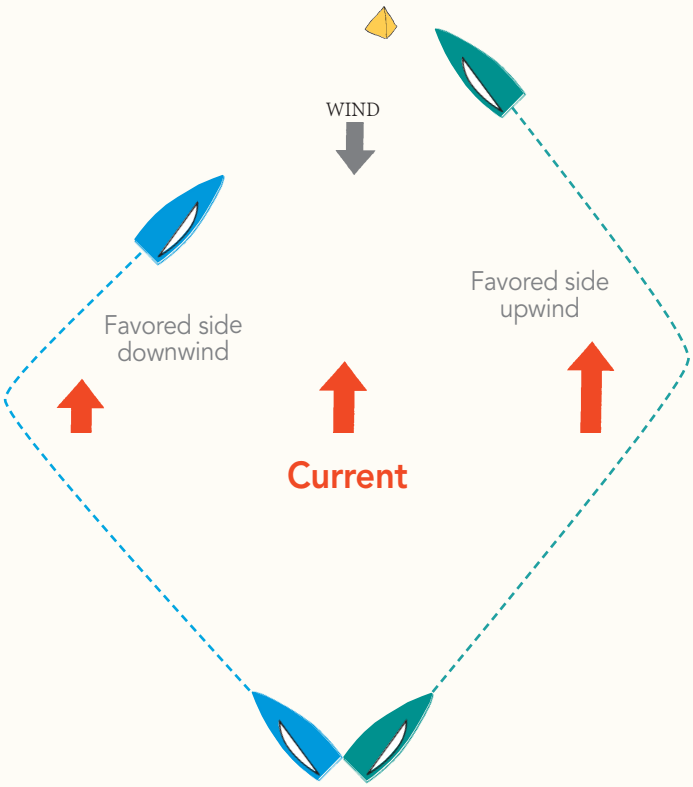
More pressure is better on both beats and runs.

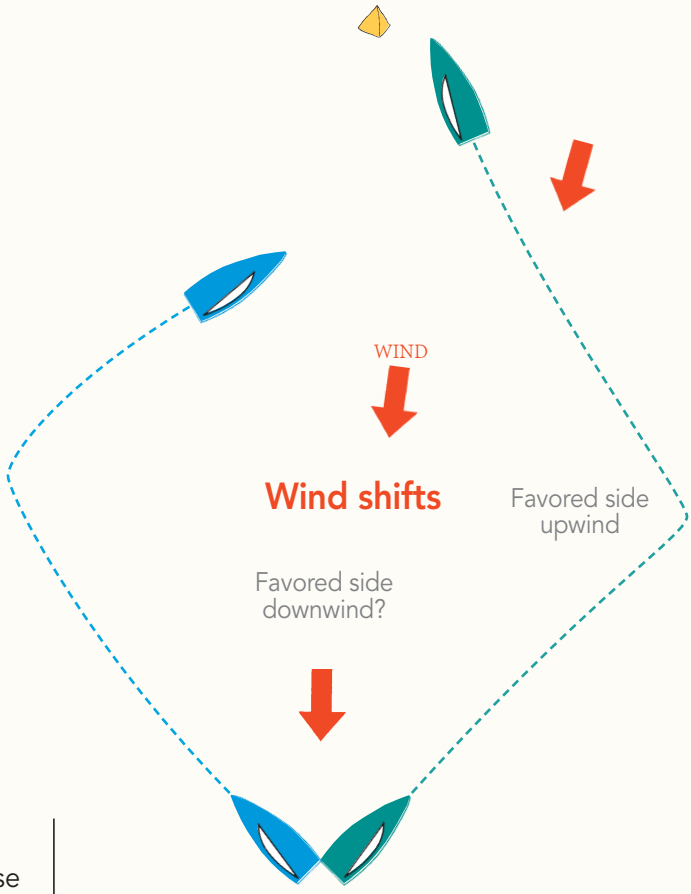
Sailing into more wind velocity will almost always help improve your boat's performance, both upwind and downwind. Even a little more pressure (sometimes just barely enough to be noticeable) will allow you to sail faster, and higher (upwind) or lower (downwind). Therefore, it's important to have an accurate understanding of what happened whenever boats make gains or losses.

If one side of the course came out ahead because the boats there had extra pressure, this must be a big part of your strategy for the next leg. Unless there is something else going on, it usually pays to round the mark and head immediately toward the side with more wind. This is especially true when you are going onto a run, where wind velocity is particularly valuable.



If one side of the course (the right side in this case) has better wind velocity, that side will likely be favored both upwind and downwind. This is especially true in light or medium breeze when even a little more pressure can make a huge difference in performance.





Current makes opposite sides favored.

If the current speed or direction is variable across the course and this favors a particular side of the windward leg, then the *opposite* side of the course will be favored downwind. This is easy to see when the current is flowing against the wind (*above*). On a beat you should sail to the side with the strongest current (the right in this case) because it's pushing you in the direction you want to go. But on a run your goal is to sail fast to leeward, so you should head for the opposite side (the left) where the current is weakest.

Race-course implications

There is clearly a lot you can learn about sailing a run by studying the previous beat, and vice versa. Here are some things to keep in mind:

- The wind direction and velocity are constantly changing, so even when it's very clear what to do on a beat or run, conditions may be different for the next leg.
- When gains are made on one side of the course because of better wind velocity, that side will be favored both upwind and downwind.
- When gains are made on one side due to variations in current velocity or direction, opposite sides of the course will be favored on runs and beats.
- When one side of a beat is advantaged because of a shift in wind direction, either side of the run could be favored.
- Make your decision about which side of the course to play *before* you round any windward mark or leeward mark. Often your best chance to implement the right strategy for the next leg is while you exit from the mark.

Windshifts could go either way.

On a beat it's common for boats to make gains on one side of the course because of a wind shift. When this happens, what should you do on the run? Sail toward the side that paid off upwind, or go the opposite way?

It's hard to make a rule of thumb about this. The best way to play shifts downwind is complicated by several factors including the fact that changes in wind direction are often accompanied by changes in velocity, and sometimes wind shifts affect only part of the course area.

When a shift on a run comes with more velocity, the extra pressure is often more valuable than the shift (*see pages 8-9*), so the rule of thumb is to go for the pressure and not worry as much about the shift. This is especially true in light to medium winds, or on fast lightweight boats, when even a little more wind makes a big difference.

If the windshift on the beat exists primarily on one side of the course (e.g. due to geographic influences), then it could make sense to go that way downwind. But if the windshifts occur across the course and there are no related changes in velocity, use classic downwind shift strategy (independent of what happened upwind). This means sailing away from the direction in which you expect the wind to shift next (*see pages 10-11*).

How important is sailing in pressure?

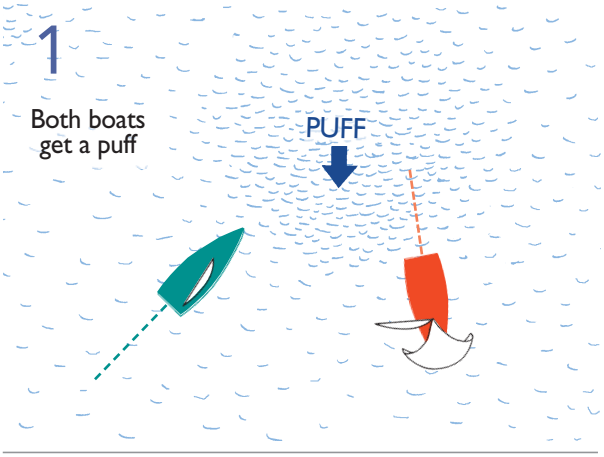
When it comes to wind velocity, more is almost always better for performance on any leg of the course. However, finding better pressure on a run usually has more strategic value than the same pressure on a beat.

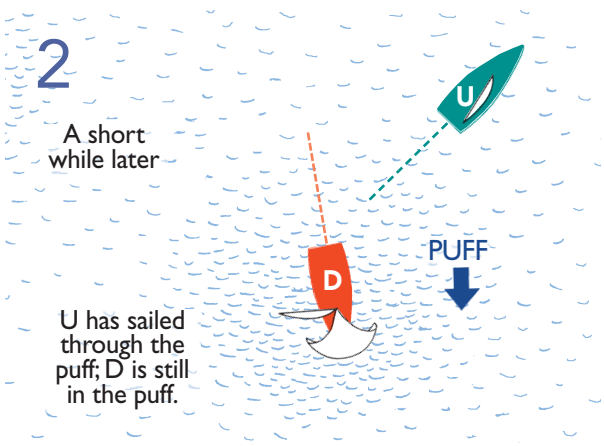
There are two main reasons for this. First, an increase in wind velocity typically improves your speed more on a run than it will on a beat. Even better, a puff affects (improves) your sailing angle much more on runs than beats. When you get more pressure on a run you can sail a lot lower, while getting a puff upwind allows you to sail just slightly higher.

A second reason why puffs are so valuable downwind is because you can stay in them much longer. On a beat you sail toward puffs and pass through them fairly quickly, but downwind you sail in the same direction as the puffs. We will look more closely at how this works on these two pages.

Laurens Morel/Delta Lloyd regatta

As it gets windier, the value of sailing in extra pressure is not as great, even on runs. If a puff brings two more knots of wind, this makes a huge difference if it takes you from 5 to 7 knots of wind. But if you are already sailing in a 20-knot breeze, two more knots won't help much. In strong breeze, playing the shifts is more important on both beats and runs.





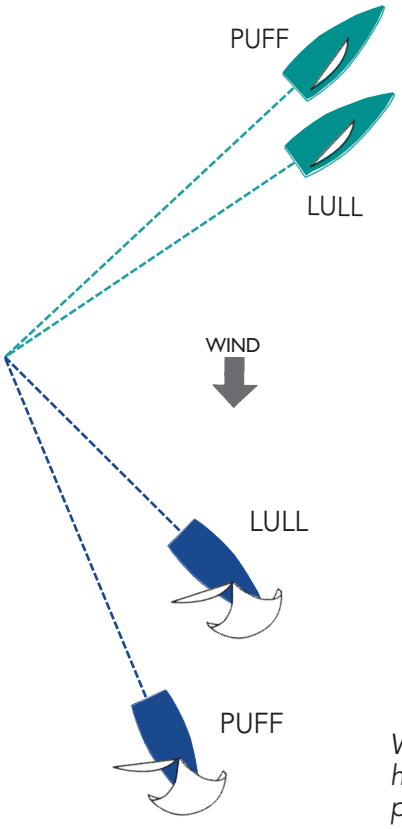
DOWNWIND: You can stay with puffs much longer.

One of the big reasons why finding more wind velocity is so valuable on runs is that boats get the benefit of sailing in that velocity for a longer time. Boats racing downwind travel in roughly the same direction as the wind and often their velocity-made-good (VMG) to leeward is almost as fast as the wind. This means that once they get into a puff they can often sail with it for quite a long way. In addition, it's easier on runs for boats to change their course to get maximum benefit out of each puff. They can head up or bear off without losing much VMG, or jibe if necessary to sail back through the puff. This combination of maneuverability and speed going with the wind means that boats can get much more out of puffs on runs than beats.

UPWIND: Puffs don't last as long.

The problem with getting puffs on a beat is that boats are traveling in the opposite direction as the puff; that is, the boats are sailing to windward while the puff is going to leeward. As a result, boats going upwind pass through puffs relatively quickly (compared to downwind), so they don't benefit from having more pressure for as long. This problem is magnified because boats going upwind don't have a lot of flexibility about choosing their course to maximize time in the puff. Tacking can be costly, and the upwind groove is narrow so it's difficult to head up or bear off very much with losing a lot of VMG.

One time when boats going upwind are less disadvantaged is when there are extended fields of pressure across the course (versus isolated, local puffs). That makes velocity more valuable because boats don't sail in and out of each puff so quickly.



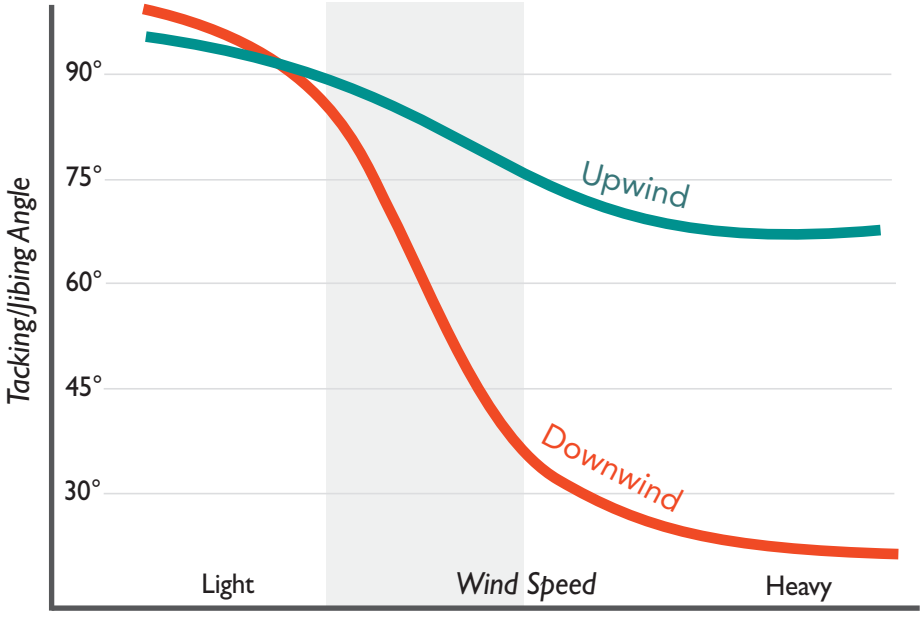
UPWIND: More wind helps speed *and* pointing.

When you're beating, a puff of wind almost always makes you go at least a little faster through the water, and it usually improves the angle at which you can sail (left). In light air, for example, your boat may tack through an angle of 90°. But if you get just a few more knots of wind you might be able to tack through 80°. That means you can point five degrees higher on each tack, which is a significant advantage (compared to boats that aren't sailing in a puff). However, the benefits of sailing in a puff upwind are relatively small compared to the advantages of getting more wind on a run.

DOWNWIND: Pressure provides a bigger performance boost.

When you are sailing downwind in light or moderate breeze, even a small amount of extra pressure will make a big difference in how deep you can sail. If you're racing in 6 knots of wind, for example, and you get just a two-knot increase in wind velocity, you may be able to sail 10° or 15° lower! Obviously, the ability to sail this much deeper (and to go faster at the same time) will get you to the leeward mark much sooner. That's why extra pressure is especially valuable downwind. Getting a puff on a run is a lot like sailing in a header, and you also go faster! Even if the wind direction does not shift at all, a puff allows you to bear off just like you would in a big header, which is why puffs are usually more valuable than shifts downwind.

When you're sailing upwind (top) and you get more pressure, you can sail a little bit higher and a little faster. But when you're racing downwind (left), even a little more pressure often means you can sail faster and a lot lower!



This chart shows the tacking and jibing angles that a boat might experience upwind and downwind over a wide range of wind velocities. As the wind velocity increases, the boat's tacking and jibing angles become narrower and narrower, which means she has better VMG.

The most notable part of the chart is the big difference between the upwind and downwind curves. More velocity leads to a modest improvement in tacking angles, but it makes for a huge decrease in jibing angles. This is why extra pressure is so beneficial on runs, especially when the wind velocity is in the shaded area where the downwind curve is steepest.

Race-course implications

More wind velocity will almost always improve your performance, so look for puffs on any leg of the course. Finding extra pressure is especially valuable downwind in light to medium breeze, so make it a high priority in these conditions.

On runs, sail toward puffs and don't worry so much about shifts. In lulls, sail high and fast so you get through them as quickly as possible. Once you get into better pressure, stay in it as long as you can by sailing a little deeper than your normal VMG (so you sail more with the pressure and less across it) and/or by jibing when you get to the edge of a puff so you sail back through it.

On beats, look for shifts as well as puffs. Finding more pressure is most valuable in light to medium air when it makes the biggest difference in your speed and pointing. Be careful of chasing too hard after puffs, though, since they won't help you as much as on a run.

What's the best way to play wind shifts?

If there's one place where the best strategy for sailing upwind is perfectly contrary to the ideal strategy for sailing downwind, it's in the realm of playing windshifts. On a beat you should usually sail *toward* the next shift you expect, but on a run you should do the opposite – sail *away from* it.

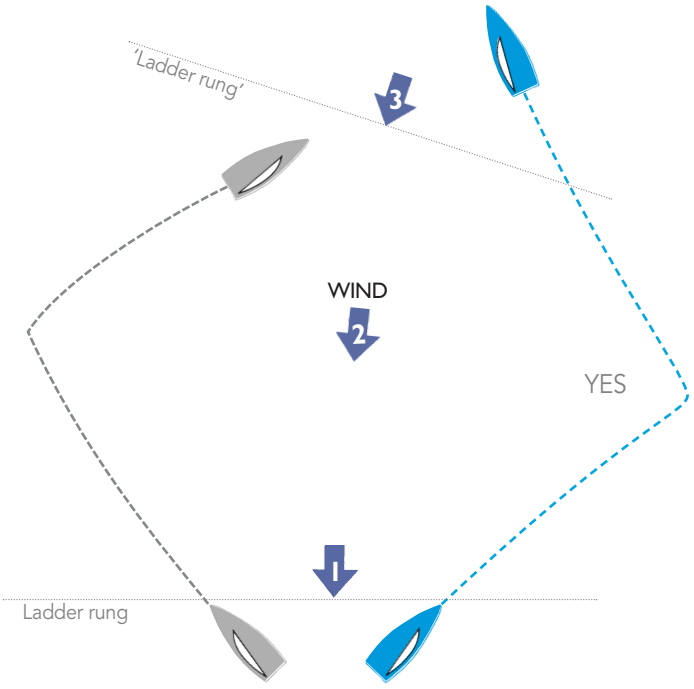
The reason for this dichotomy is that you have completely different goals on beats and runs. On a beat your goal is to move to windward as quickly as possible. This means climbing up the ladder rungs so you make progress in a windward direction. If the wind is going to shift, you can get to a higher ladder rung simply by being closer to the direction of the shift.

On a run, however, your goal is to move to leeward by climbing *down* the ladder rungs. Sailing toward the next shift is not a good idea because you'll end up on a higher ladder rung when the wind shifts. Sailing away from the shift is the way to end up on a lower ladder rung. The goal is to maximize VMG, like upwind, but the way you must do it is opposite.

'Ladder rungs'

Ladder rungs are imaginary lines drawn on the water surface perpendicular to the wind direction. On a beat or run, boats on the same ladder rung are equal in the race. Upwind you want to climb up to a higher rung while on a run you want to get to a lower rung. If the wind changes direction the angle of the ladder rungs (and therefore the boats' positions in the race) will also change.

UPWIND: Sail *toward* the next windshift

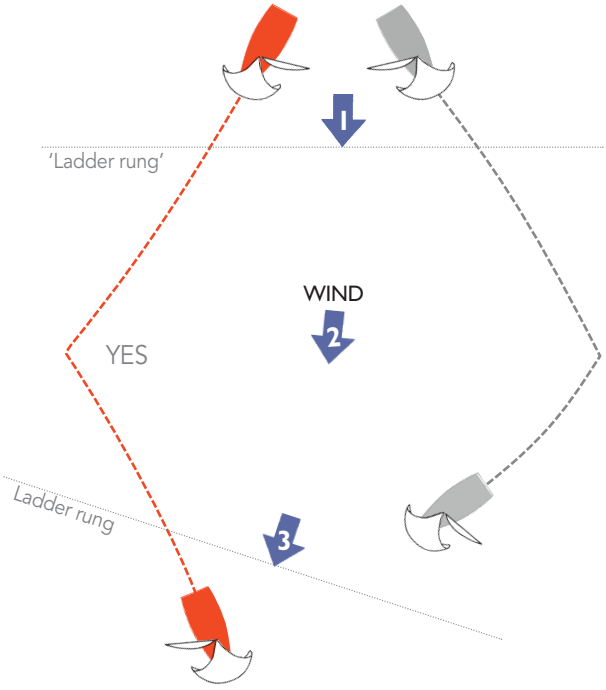


When you are expecting the wind direction to change (as it almost always does), the basic principle for upwind strategy is to sail in the direction of the anticipated windshift. If you think the wind will veer (shift clockwise, to the right), sail on port tack toward that shift (*see above*). If you think the wind will back (shift counter-clockwise, to the left), sail on starboard tack.

By sailing toward the next shift, you will be closer to the new wind direction and will therefore end up on a higher ladder rung when the shift comes. This means you will be farther upwind and more advanced in racing toward the windward mark.

Shifts are usually more valuable on beats than runs, so work hard to figure out where the next shift will come from. When you're not sure, sail the longer tack first.

DOWNWIND: Sail *away from* the next shift



On a beat you should sail toward the next windshift, but on a run the opposite is true – sail away from where you expect the next shift. If you think the wind will veer (shift clockwise, to the right), sail on starboard jibe away from that shift (*see above*). If you think the wind will back (shift counter-clockwise, to the left), sail on port jibe first.

By getting farther away from the direction of the next shift you will end up on a lower ladder rung when that shift comes. This means you will be farther downwind and more advanced in racing to the leeward mark.

Be careful about this rule if the next wind shift may bring an increase in velocity (*see next page*). Pressure is critical on runs, so think twice before sailing away from it. This isn't a problem on beats because you sail toward the next shift which also takes you toward the pressure.

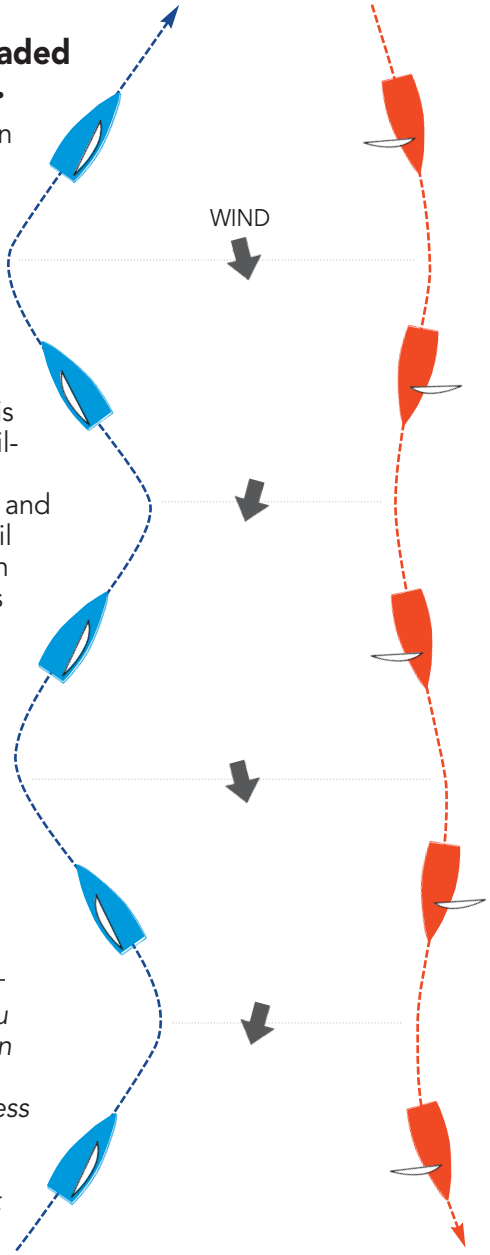
UPWIND:

Tack when you get headed so you sail on the lifts.

Most sailors know that when the wind is oscillating you should tack when you get headed. This will put you on the lifted tack, which will bring you more directly up the upwind 'ladder' toward the windward mark.

Tacking on the headers is also very consistent with sailing toward the next shift. If you are sailing on port tack and you get headed (i.e. you sail into a right shift), the reason why you tack on that shift is because the next shift you expect is a lefty. When you expect a left shift, sail on starboard tack toward it.

Of course, if you get headed on port tack and you think the wind is shifting persistently, don't tack. The next shift will come from the right, so keep sailing on port tack.



*In an oscillating breeze, you should sail the **lifted** tack on a beat (Blue boat) because your goal is to make progress to windward. But on a run (Red boat) you're trying to get to leeward so you want to sail on the **headed** tack.*

DOWNWIND:

Jibe when you get lifted so you sail on the headers.

When the wind is oscillating downwind, jibe when you get lifted. This keeps you on the headed tack, which will bring you more directly down the downwind 'ladder' toward the leeward mark.

Jibing on the lifts is also consistent with sailing away from the next shift you expect. If you are on port tack and you get lifted (i.e. the wind shifts to the left), the reason why you jibe to starboard is because the next shift you expect is a righty. When you're expecting a right shift on a run, you should sail away from it on starboard jibe.

Remember that you are sailing with the wind on a run so you won't see as many oscillating shifts as you do on a beat.

Race-course implications

These two pages are already full of things to remember about shifts on beats and runs, but here are a few reminders:

- The correct strategy downwind is to sail away from the next shift you expect, but be careful about doing this if you see better pressure coming with that shift.
- Since you normally see fewer shifts on runs than beats, it's more likely that you may treat some downwind shifts as persistent (rather than oscillating). There is a point during any run (and this is relatively early compared to beats) where you are not going to see any more shifts. It's important to treat that last shift as a persistent one and not assume it will oscillate again before you get to the leeward mark.

The danger of sailing *away from* the next shift on a run

In theory, the right way to play windshifts downwind is to sail away from the direction where you expect the wind to shift next so you'll be on a lower ladder rung when the shift comes. But this doesn't always work out best in practice.

The problem is that changes in wind direction are often accompanied by increases in wind velocity. If you sail away from the shift, you may also be sailing away from the best pressure.

Since additional wind is so valuable on a run, the gains from getting into better pressure often outweigh the loss that comes with sailing toward the shift. This means the choice of which way to go is often difficult.

The Green boat is going the right way to play the windshift, but the Red boat will have better pressure. Who's right depends on how much the wind shifts and how much more pressure there is on the right side.

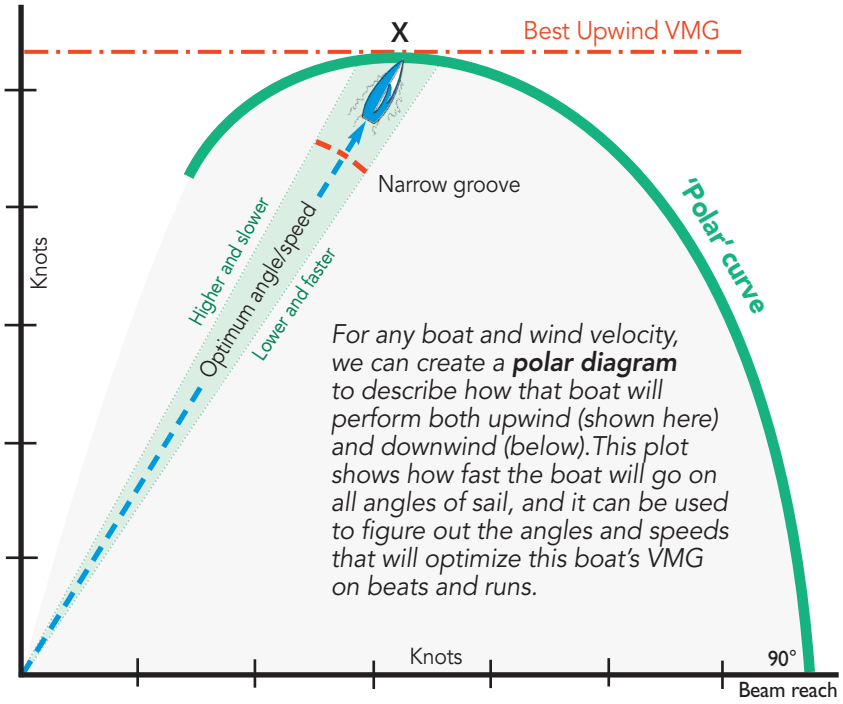
Finding the sweet spot

One of the biggest differences between sailing upwind and downwind is the nature of the 'groove.' The groove is a mode of sailing (i.e. an angle and speed) where you achieve optimal VMG toward the windward or leeward mark. It is usually narrower upwind and wider downwind, which affects your boatspeed, strategy and tactics.

Having a narrow groove upwind is good and bad. A well-defined groove is usually easier to find on a consistent basis than the wider, less-defined groove downwind. This means it's easier to keep your boat going fast upwind for a larger percentage of the time. But a narrow groove gives you fewer options on the race course. If you sail much higher or lower than your optimal angle, you lose a lot of VMG (*see right*). This puts a limit on how much you can head up or bear off to avoid bad air or get to puffs, for example.

Having a wider groove downwind has similar pluses and minuses. Since you can often head quite a bit higher or lower on a run without losing much VMG (*see below*), you have more strategic and tactical options (without the need for jibing). But this same indistinct groove means it's more difficult to get locked into a fast mode all the time.

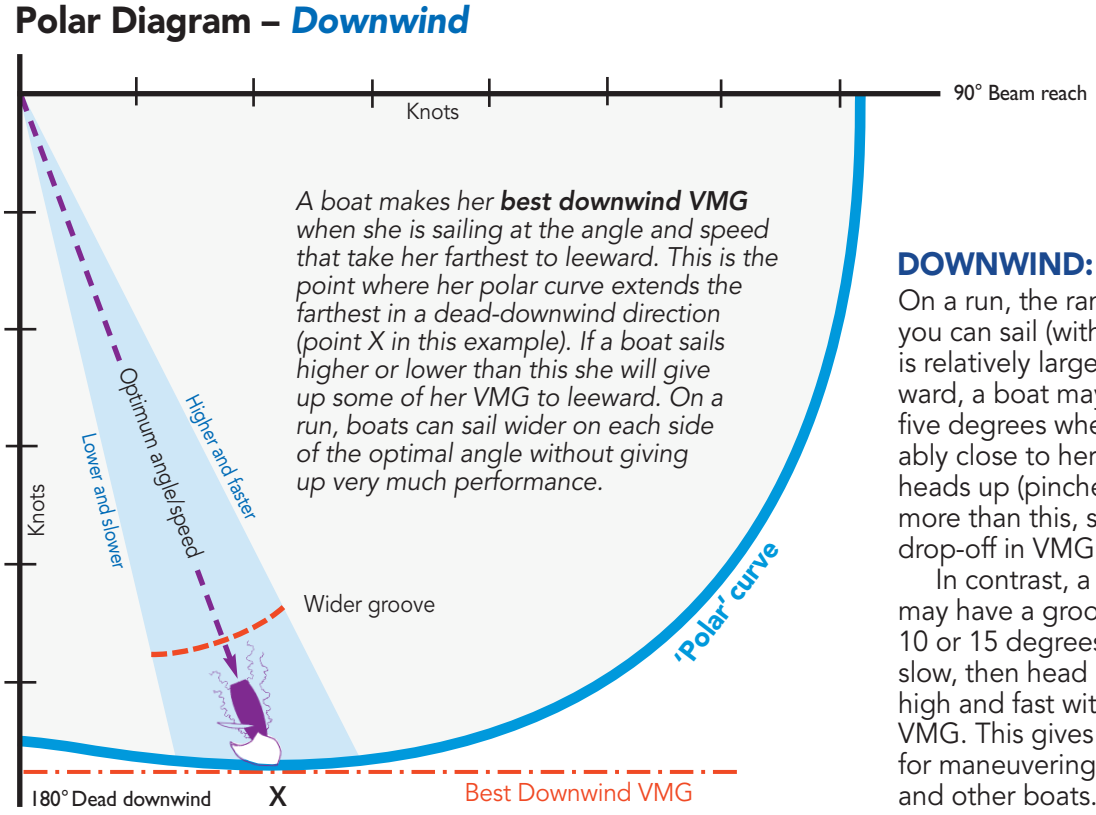
Polar Diagram – *Upwind*



UPWIND: A relatively narrow groove

When you are sailing upwind, your choice of possible angles and speeds to sail is fairly limited. As you can see from this typical polar diagram, if a boat diverts (i.e. heads up or bears off) very much from the angle that provides her optimal VMG to windward (Point X), she will suffer a fairly steep drop-off in performance.

Polar Diagram – *Downwind*



DOWNWIND: A wider groove

On a run, the range of headings that you can sail (without losing much VMG) is relatively large. When sailing to windward, a boat may have a range of only five degrees where she is sailing reasonably close to her optimal VMG. If she heads up (pinches) or bears off (foots) more than this, she will see a steep drop-off in VMG.

In contrast, a boat sailing downwind may have a groove that is as wide as 10 or 15 degrees! She can sail low and slow, then head up 15 degrees to sail high and fast without a significant loss in VMG. This gives her a lot more options for maneuvering relative to the wind and other boats.

UPWIND: Reliable 'groove'

A boat sailing upwind has a narrow operating range (as far as being in the groove is concerned), but at least it's fairly easy to find that groove and stay in it. The jib telltales are clear indicators of when you are (and aren't) sailing on the wind. The feel of the wind on your face, the tug of weather helm on the rudder and the boat's angle of heel are all very helpful for staying in the groove once you get there.

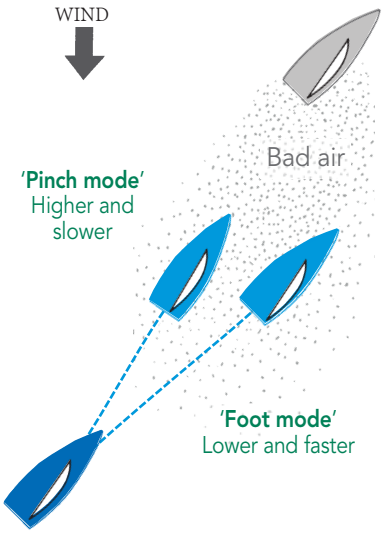
Two other things make the groove easier upwind: 1) a boat's best upwind angle does not change very much with variations in wind velocity; and 2) it's not hard to adjust sail trim to make the boat more forgiving and easier to sail.

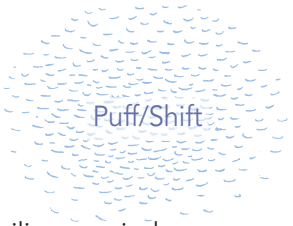
DOWNWIND: Indistinct 'groove'

Boats that are sailing downwind do have a 'groove,' but it is less defined than when sailing upwind. There are no jib telltales to use as guides, and there's usually much less feel in the helm. The ideal downwind angle changes all the time due to fluctuations in wind velocity, so it's hard to be confident that you are sailing at the right angle and speed all the time. That's why the whole crew needs to work hard together on this.

JH Peterson photo

Instruments are much more helpful for staying in the groove upwind than they are downwind. On a run, your 'target' true wind angle and boatspeed change frequently with wind velocity, so it's hard to key on these while steering. But on a beat these stay fairly constant, so you can use them to sail the boat.



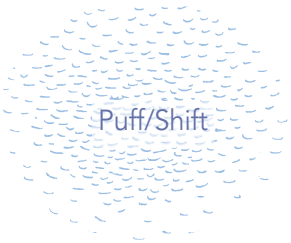


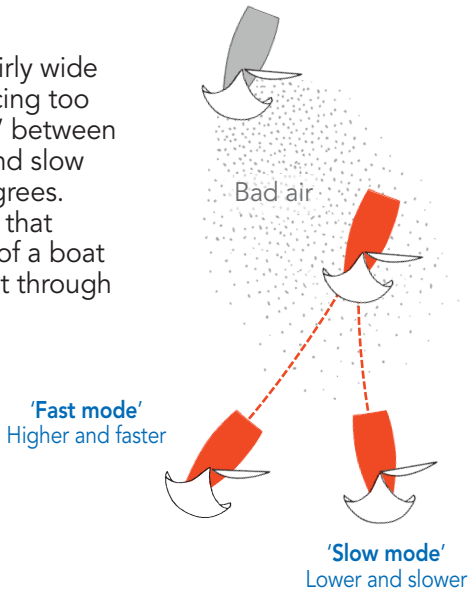
Upwind

When you're sailing upwind, you don't have a huge choice of angles to sail. You can aim high and slow in pinch mode, or bear off into foot mode. But if you pinch or foot too much you will lose a lot of VMG. In most boats you have a 'working groove' of roughly 5 degrees. This means it often doesn't work well to pinch or foot for tactical (e.g. to avoid bad air) or strategic (e.g. to get to a puff) reasons.

Downwind

On a run, you can usually sail a fairly wide range of headings without sacrificing too much VMG. The 'working groove' between sailing high and fast versus low and slow could easily be 10 or even 15 degrees. That is a significant angle change that can be used to avoid the bad air of a boat behind, for example, or to sail fast through a lull toward the next puff.





Race-course implications

When sailing upwind you have a narrow groove that is relatively easy to find. Downwind the groove is significantly wider but less defined. What does all this mean for sailing fast around the course?

As far as boatspeed goes, it's important for the whole crew to feel the boat and look around so they can keep the boat going fast. This is especially true downwind where the helmsperson doesn't feel very much through the rudder. Make sure all crewmembers focus on communication, keeping their heads out of the boat and tuning in to how the boat feels.

From a strategic and tactical point of view, you have more options on runs where the groove is wider. Because you can sail quite a bit higher or lower without compromising VMG, you can move around the course more. This makes it easier to avoid areas (e.g. where there is bad air, a lull or a crowd of boats) or sail more quickly to other areas (e.g. where there is a puff, shift or boat you need to cover).

The nature of laylines

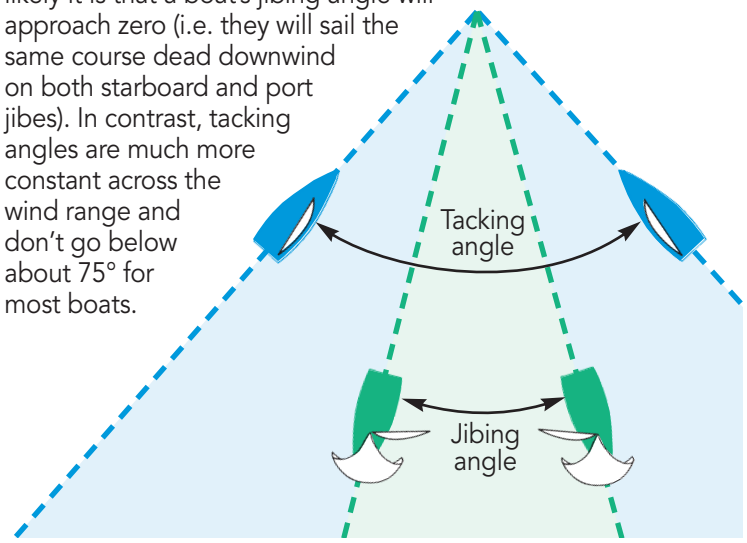
A layline is an imaginary line drawn from the windward or leeward mark showing the course of a boat that is sailing optimally toward that mark on starboard or port tack. Laylines are important boundary markers – they show where you must eventually be in order to round the mark and the position beyond which you are overstanding and sailing extra distance.

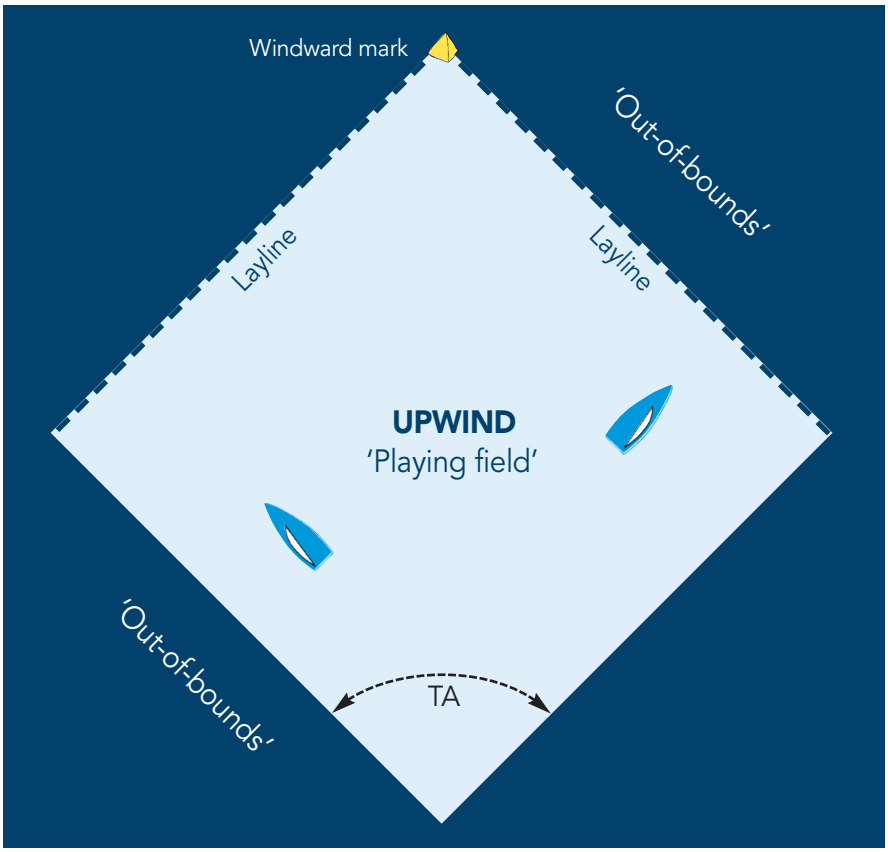
In theory, laylines to the windward and leeward marks are very similar. But in practice, they behave quite differently. Laylines are a function of a boat's optimal sailing angle (i.e. the course a boat would sail to make her best VMG upwind or downwind), so whenever this sailing angle changes, laylines also change.

Of course, laylines are affected by changes in wind direction, both upwind and downwind. But they are also very much a function of wind velocity. Whenever you get a change in pressure, this affects your sailing angle and thus your laylines. However, changes in velocity have a much greater impact on runs than beats, for reasons explained on this page and the next.

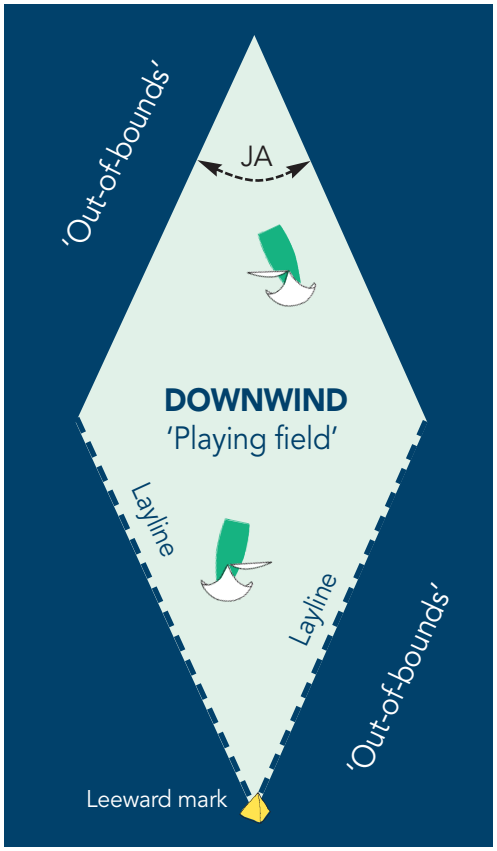
Tacking angle vs. jibing angle

On most boats and in most conditions, the difference in angle between starboard and port jibes (jibing angle) is at least a little (and often a lot) narrower than the angle between starboard and port tacks (tacking angle). Many boats, especially those with symmetrical chutes or no spinnakers at all, sail very deep downwind. The stronger the wind and the bigger the waves, the more likely it is that a boat's jibing angle will approach zero (i.e. they will sail the same course dead downwind on both starboard and port jibes). In contrast, tacking angles are much more constant across the wind range and don't go below about 75° for most boats.



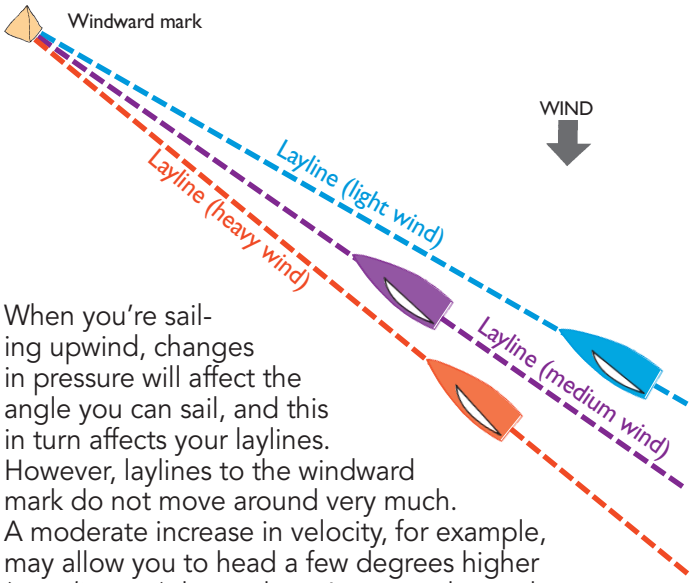


UPWIND The angles you sail on port and starboard tacks are normally almost 90° apart, which makes the upwind 'playing field' wide, almost square. With a large field, it's easier to stay in-bounds and avoid laylines.



DOWNWIND When sailing on a run your playing field is often much narrower, more like a diamond (except for boats with asymmetrical chutes that sail high angles). With a smaller field, it's easier to get 'out of bounds' and go beyond the laylines.

UPWIND: Laylines are fairly consistent.



When you're sailing upwind, changes in pressure will affect the angle you can sail, and this in turn affects your laylines. However, laylines to the windward mark do not move around very much. A moderate increase in velocity, for example, may allow you to head a few degrees higher (*see diagram*), but it doesn't cause a huge change. That's why closehauled laylines are fairly consistent and relatively easy to call in a wide range of conditions.

In contrast, similar velocity increases on a run may change the downwind angle you sail by 10° or 20°! This changes the laylines dramatically and makes it much more difficult to pick them (*see right*).

Race-course implications

Whether you are beating or running, the laylines are usually not a good place to be. The farther you are from the next mark when you reach the layline, the more likely you are to lose due to bad air, a windshift or simply overstanding the mark.

This risk of getting to a layline early is greater on runs than beats. There are two reasons for this: First, the downwind playing field is usually much smaller than the upwind field, so you are always near a layline. If the run is skewed at all, it's easy to overstand the leeward mark, especially if it's windy and you are sailing nearly dead downwind.

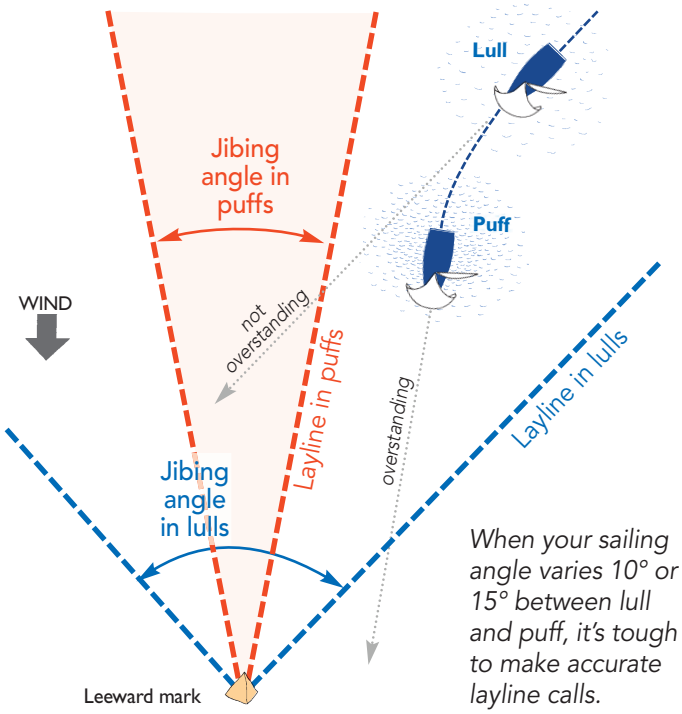
The second reason is that laylines to the leeward mark change dramatically with variations in wind pressure. This makes it harder to identify laylines and easy to overstand. A good rule of thumb downwind is not to pick close (tight) laylines, especially when you're far from the mark and/or the wind velocity is variable.

▶ Laylines to the windward mark are not usually tricky to call, but trying to pick a layline to the leeward mark can be very challenging, especially in puffy conditions.

DOWNWIND: Laylines are tricky to call.

Laylines move around much more on runs than beats. When you're sailing downwind in a light to medium breeze, any small increase (or decrease) in wind velocity can change the angles you sail dramatically.

Whenever your sailing angle changes, your laylines change correspondingly. If a puff allows you to sail 15° lower, this means each downwind layline will move 15°. This is a huge change, but it's not unusual when you are racing downwind in light and puffy conditions. That's why changes in velocity have a much bigger impact on downwind laylines than on upwind laylines.



When your sailing angle varies 10° or 15° between lull and puff, it's tough to make accurate layline calls.

Laurens Morel/Delta Lloyd regatta

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Consider the cost of changing tacks

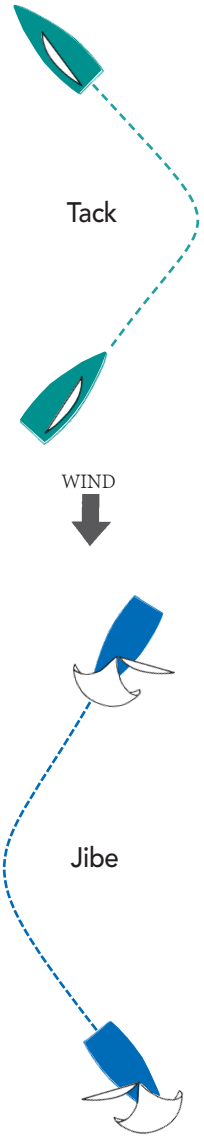
One thing that's similar about beats and runs is that you must always sail on either port or starboard tack. And this choice is a key part of implementing your strategic plan for that leg.

But changing from one tack to the other is not done in the same way – on beats you must *tack*; on runs you *jibe*. Both maneuvers cost distance (compared to boats that don't tack or jibe), but the relative costs can vary widely depending on your boat and the conditions.

Therefore, when pursuing a strategic plan, you must keep in mind the cost of tacking or jibing. This will help determine whether it makes sense to tack or jibe on a small shift or puff, for example.

Wind strength	Distance Lost (boatlengths)	
	TACK	**JIBE**
Light	3	2
Medium	1.5	.75
Heavy	2	1

Here is a 'Distance Lost' chart for a typical one-design boat. Of course, the actual numbers may vary quite a bit according to boat type, wave state and crew experience. But in most cases you will lose more distance during a tack than during a jibe, and this will affect your strategic and tactical choices for beats and runs.



UPWIND: You usually lose a lot in tacks.

Tacking is slow for several reasons. When you change from one tack to the other you must sail straight into the wind for a brief time, aim right into the waves during the tack, luff your sails and make a fairly sharp turn. The drag caused by all these actions reduces your speed significantly and makes tacking a relatively costly maneuver, especially in waves and light or heavy air.

Therefore, whenever you are thinking about a tack, consider whether the distance you give up during the maneuver will be worth the potential gains you make by sailing on the other tack. In many situations on upwind legs, a tack costs too much unless you have a significant shift or puff (or unless your boat tacks easily in the conditions).

DOWNWIND: Jibes are less costly.

Jibing is less painful than tacking for several reasons. When you change from one jibe to the other you sail straight downwind for a brief time, go in the same direction as the waves, keep your sails full the whole time and make a fairly gradual turn. These actions don't create nearly as much drag as their tacking counterparts, so jibes won't usually hurt your speed like tacks.

What this means is that you can jibe to take advantage of smaller changes in the wind. If you get a slight lift, for example, or you see a little more pressure to leeward, it's OK to jibe. Even if you don't realize any advantage by jibing, the cost of that maneuver will not hurt you very much. This is in contrast to upwind legs when a tack (or two tacks since you usually have to tack again) could make a huge difference in your position, especially if you don't gain much strategically.